Comment on 'Oblique Propagation and Dissipation of Alfvén Waves in Coronal Holes' by Srivastava and Dwivedi

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Paper has been submitted to J. Astrophy. Astron. on 2 June 2007 and decision is awaited for quite long time.

Abstract: We comment on the recent paper by Srivastava and Dwivedi (J. Astrophs. Astr. **28**, 1, 2007). In the said paper the derived dispersion relation $\nu\eta\cos^4\theta\ k^4 + [v_A^2 - i\omega(\nu+\eta)]\cos^2\theta k^2 - \omega^2 = 0$ seems to be in error. Consequently, the conclusion drawn in their paper are not reliable.

1 Introduction

In their recent paper, Srivastava and Dwivedi (2007, henceforth SD) investigated the oblique propagation and dissipation of Alfvén waves in coronal holes where the basic equations used by them are

$$\rho\frac{\partial \vec{v}}{\partial t} + \rho(\vec{v}\ .\nabla)\ \vec{v} = \frac{1}{\mu}(\nabla\times\vec{B})\times\vec{B} + \rho\nu\nabla^2\vec{v} \qquad \text{Momentum equation} \tag{1}$$

$$\frac{\partial \vec{B}}{\partial t} = \nabla\times(\vec{v}\times\vec{B}) + \eta\nabla^2\vec{B} \qquad \text{Induction equation} \tag{2}$$

$$\nabla.\ \vec{B} = 0 \qquad \text{Magnetic flux conservation} \tag{3}$$

where $\vec{v}$ is the velocity, $\vec{B}$ the magnetic field and ρ, μ, η, ν are respectively the mass density, magnetic permeability, magnetic diffusivity and the coefficient of viscosity. For small perturbations (represented by a suffix 1) from the equilibrium (represented by a suffix 0) (Priest, 1982):

$$\rho = \rho_0 + \rho_1 \qquad \vec{v} = \vec{v}_1 \qquad \vec{B} = \vec{B}_0 + \vec{B}_1$$

and after linearization, equations (1) and (2), reduces to (Pekünlü et al, 2002; SD)

$$\rho_0\frac{\partial \vec{v}_1}{\partial t} = \frac{1}{\mu}(\vec{B}_0\ .\nabla)\ \vec{B}_1 + \rho_0\nu\nabla^2\vec{v}_1 \tag{4}$$

$$\frac{\partial \vec{B}_1}{\partial t} = (\vec{B}_0\ .\nabla)\ \vec{v}_1 + \eta\nabla^2\vec{B}_1 \tag{5}$$

Here, the magnetic field $\vec{B}_0$ is taken uniform as well as time independent. A usual practice has been to consider plane-wave solutions (Priest, 1982; Porter et al., 1994; Pekünlü et al., 2002; Kumar et al., 2006)

$$\vec{v}_1 = \vec{v}\ \ e^{i(\vec{k}.\vec{r}-\omega t)} \qquad \vec{B}_1 = \vec{B}\ \ e^{i(\vec{k}.\vec{r}-\omega t)} \tag{6}$$

where $\vec{k}$ is the wave vector and ω the frequency. The effect of the plane-wave assumption is simply to replace $\partial/\partial t$ by $-i\omega$ and ∇ by $i\vec{k}$. Form equations (4) and (5) with the plane-wave solutions, Pekünlü et al. (2002) obtained the dispersion relation

$$\nu\eta k^4 + \left[v_A^2 - i\omega(\nu+\eta)\right]k^2 - \omega^2 = 0 \tag{7}$$

This dispersion relation has been used by Dwivedi and Srivastava (2006) for propagation and dissipation of Alfvén waves in coronal holes. Recently SD tried to extend this work in an erroneous manner, as discussed in the following section.

2 Flaw in the work of SD

In the name of a oblique propagation, SD modified equations (6) to the form

$$\vec{v}_1 = \vec{v}\ \ \mathrm{e}^{i(\vec{k}\,.\,\vec{r}\,|\cos\theta| - \omega t)} \qquad\qquad \vec{B}_1 = \vec{B}\ \ \mathrm{e}^{i(\vec{k}\,.\,\vec{r}\,|\cos\theta| - \omega t)} \tag{8}$$

In the paper of SD, it is not clear where this angle θ exists; it is obviously not between $\vec{k}$ and $\vec{r}$. To our understanding, these expressions (8) have no physical meaning. By doing so, SD replaced $\partial/\partial t$ by $-i\omega$ and ∇ by $i\vec{k}\ |\cos\theta|$ in the equations (4) and (5), and obtained the dispersion relation

$$\nu\eta\cos^4\theta\ k^4 + \left[v_A^2 - i\omega(\nu+\eta)\right]\cos^2\theta k^2 - \omega^2 = 0 \tag{9}$$

After using this dispersion relation, SD calculated various parameters.

Earlier also, an unphysical situation was created by the same group. In their paper, Dwivedi and Pandey (2003, henceforth DP) considered a new energy equation and concluded that the results of Porter et al. (1994) and of Pekünlü et al. (2002) were in error and advised to replace the energy equation by Equation (4) of DP. As discussed by Klimchuk et al. (2004) also, the energy equation of DP is wrong from the dimension point of view. Thus, the advice of DP was based on an unphysical situation. For the paper of DP, the Editor of Solar Physics invited DP to prepare an apology.

Our objection is that the dispersion relation (9) derived by using the equations (8) is not correct. To our knowledge, no waves can be expressed by the relations (8). In view of this objection, the investigation of SD is not reliable.

3 Acknowledgments

This work was done during the visit of the authors to the IUCAA, Pune. Our special thanks are due to Prof. A.K. Kembhavi for encouragement.

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